Beam Sensitive-glass in bodies of 0.090 inch cross section will exhibit the following properties:

(a) transmittance of more than 88% at 436 nm; and

(b) upon exposure to an electron beam using an electron beam pattern generator operated with a write scheme having a value of acceleration voltage selected from 20 to 30 kV, an addressing grid size of from 0.1 to 0.4 micrometer, and a value of beam current selected from 25 to 250 na, an electron beam darkening sensitivity in the linear portion of the sensitivity curve, of at least 2.454 unit of optical density value in the spectral range of 365 nm to 630 nm per electron dosage unit of milli coulomb/cm^2, said HEBS-glass having a base glass composition consisting essentially on the mole % oxide basis 11.4 to 17.5% of one or more alkali metal oxide, 2.4 to 10.2% of photosensitivity inhibitors and RS suppressing agents with at least 2.4% TiO_2; 1.1 to 2.4% $A1_2O_3$; 0 to 4.6% B_2O_3; 3.7 to 13.2% ZnO; 0.5 to 6% Cl; and 58.2 to 78.8% SiO_2.

22. The gray scale mask according to Claim 21 wherein at least one gray scale zone has a continuous gray scale comprising a plurality of grade scale levels.

23. A method of making a gray scale mask comprising writing on a plurality of areas on at least a portion of a High Energy Beam Sensitive-glass (HEBS-glass) with an electron beam having an acceleration voltage of 20 to 30 kiloVolts, a beam current of 25 to 175 nanoamps, and addressing a grid size of 0.1 to 0.4 micron; the writing carried out at an electron dosage that falls on the net optical density vs. electron dosage sensitivity curve of the High Energy Beam Sensitive-glass, the initial slope of the sensitivity curve being from 2.454 to 12.507 per electron dosage unit of milli-coulombs/cm^2; the exposure

duration of the writing on each area are different than the exposure duration of the immediate adjacent areas; the High Energy Beam Sensitive-glass in bodies of 0.090 inch cross section will exhibit the following properties:

(a) a transmittance of more than 88% at 436 nm; and

(b) upon exposure to an electron beam using an electron beam pattern generator operated with a write scheme having a value of acceleration voltage selected from 20 to 30 kV, an addressing grid size of from 0.1 to 0.4 micrometer, and a value of beam current selected from 25 to 250 na, an electron beam darkening sensitivity in the linear portion of the sensitivity curve, of at least 2.454 unit of optical density value in the spectral range of 365 nm to 630 nm per electron dosage unit of milli coulomb/cm^2; said HEBS-glass having a base glass composition consisting essentially on the mole % oxide basis 11.4 to 17.5% of one or more alkali metal oxide, 2.4 to 10.2% of photosensitivity inhibitors and RS suppressing agents with at least 2.4% TiO_2; 1.1 to 2.4% $A1_2O_3$; 0 to 4.6% B_2O_3; 3.7 to 13.2% ZnO; 0.5 to 6% Cl; and 58.2 to 78.8% SiO_2.

24. A method of making a three dimensional microstructure with three dimensional surfaces in a photoresist comprising exposing a photoresist to a gray scale pattern in a gray scale mask using an optical lithography tool and developing the exposed photoresist to form three dimensional microstructures in the photoresist;

the gray scale mask comprising a transparent High Energy Beam Sensitive-glass (HEBS-glass) having at least one gray scale zone with a plurality of gray scale levels, each gray scale level having a different optical density, the High Energy Beam Sensitive-glass in bodies of 0.090 inch cross section will exhibit the following properties:

(a) a transmittance of more than 88% at 436 nm; and

(b) upon exposure to an electron beam using an electron beam pattern generator operated with a write scheme having a value of acceleration voltage selected from 20 to 30 kV, an addressing grid size of from 0.1 to 0.4 micrometer, and a value of beam current selected from 25 to 250 na, an electron beam darkening sensitivity in the linear portion of the sensitivity curve, of at least 2.454 unit of optical density value in the spectral range of 365 nm to 630 nm per electron dosage unit of milli coulomb/cm^2; said HEBS-glass having a base glass composition consisting essentially on the mole % oxide basis 11.4 to 17.5% of one or more alkali metal oxide, 2.4 to 10.2% of photosensitivity inhibitors and RS suppressing agents with at least 2.4% being TiO_2; 1.1 to 2.4% $A1_2O_3$; 0 to 4.6% B_2O_3; 3.7 to 13.2% ZnO; 0.5 to 6% Cl; and 58.2 to 78.8% SiO_2.

25. An analog photoresist with a three dimensional microstructure produced by exposing a photoresist to a gray scale pattern in a gray scale mask using an optical lithography tool and developing the exposed photoresist to form the three dimensional microstructure in the photoresist; the gray scale mask comprising:

A gray scale mask comprising a transparent High Energy Beam Sensitive-glass (HEBS-glass) having at least one gray scale zone with a plurality of gray scale levels, each gray scale level having a different optical density, the High Energy Beam Sensitive-glass in bodies of 0.090 inch cross section will exhibit the following properties:

(a) a transmittance of more than 88% at 436 nm; and

(b) upon exposure to an electron beam using an electron beam pattern generator operated with a write scheme having a value of acceleration voltage selected from 20 to 30 kV, an addressing grid size of from 0.1 to 0.4 micrometer, and a value of beam current selected from 25 to 250 na, an electron beam darkening sensitivity in the linear portion of the sensitivity curve, of at least 2.454 unit of optical density value in the spectral range of 365 nm to 630 nm per electron dosage unit of milli coulomb/cm^2, said HEBS-glass having a base glass composition consisting essentially on the mole % oxide basis 11.4 to 17.5% of one or more alkali metal oxide, 2.4 to 10.2% of photosensitivity inhibitors and RS suppressing agents with at least 2.4% being TiO_2 1.1 to 2.4% $A1_2O_3$; 0 to 4.6% B_2O_3; 3.7 to 13.2% ZnO; 0.5 to 6% Cl; and 58.2 to 78.8% SiO_2.

26. A method of producing three dimensional microstructures in substrate material comprising exposing a substrate through a developed analog photoresist with a three dimensional microstructure with an ion beam in an ion beam etching system to transfer the three dimensional microstructure of the developed analog photoresist on to the surface of the substrate in a single step exposure; the analog photoresist with three dimensional microstructure being the product of the process comprising exposing a photoresist to a gray scale pattern in a gray scale mask using an optical lithography tool and developing the exposed photoresist to form three dimensional microstructures in the photoresist; the gray scale mask comprising a transparent High Energy Beam Sensitive-glass (HEBS-glass) having at least one gray scale zone with a plurality of gray scale levels, each gray scale level having a different optical density, the High Energy Beam Sensitive-glass in bodies of 0.090 inch cross section will exhibit the following properties:

(a) a transmittance of more than 88% at 436 nm; and

(b) upon exposure to an electron beam using an electron beam pattern generator operated with a write scheme having a value of acceleration voltage selected from 20 to 30 kV, an addressing grid size of from 0.1 to 0.4 micrometer, and a value of beam current selected from 25 to 250 na, an electron beam darkening sensitivity in the linear portion of the sensitivity curve, of at least 2.454 unit of optical density value in the spectral range of 365 nm to 630 nm per electron dosage unit of milli coulomb/cm^2, said HEBS-glass having a base glass composition consisting essentially on the mole % oxide basis 11.4 to 17.5% of one or more alkali metal oxide, 2.4 to 10.2% of photosensitivity inhibitors and RS suppressing agents with at least 2.4% being TiO_2; 1.1 to 2.4% $A1_2O_3$; 0 to 4.6% B_2O_3; 3.7 to 13.2% ZnO; 0.5 to 6% Cl; and 58.2 to 78.8% SiO_2.

27. A component having a three dimensional microstructure selected from the group consisting of tapered structures for microelectronics, micro-optical devices, integrated optical components, micro-electro-mechanical devices, micro-opto-electro-mechanical devices, microelectrical devices, diffractive optical elements (DOE), refractive microlens arrays, micromirror arrays, and diffractive microlens arrays; the component comprising a substrate having a three dimensional microstructure produced by exposing a substrate through a developed analog photoresist with a three dimensional microstructure with an ion beam in an ion beam etching system to transfer the three dimensional microstructure of the developed analog photoresist on to the surface of the substrate in a single step exposure; the analog photoresist with three dimensional microstructure being the product of the process comprising exposing a

photoresist to a gray scale pattern in a gray scale mask using an optical lithography tool and developing the exposed photoresist to form three dimensional microstructures in the photoresist; the gray scale mask comprising a transparent High Energy Beam Sensitive-glass (HEBS-glass) having at least one gray scale zone with a plurality of gray scale levels, each gray scale level having a different optical density, the High Energy Beam Sensitive-glass in bodies of 0.090 inch cross section will exhibit the following properties:

(a) a transmittance of more than 88% at 436 nm; and

(b) upon exposure to an electron beam using an electron beam pattern generator operated with a write scheme having a value of acceleration voltage selected from 20 to 30 kV, an addressing grid size of from 0.1 to 0.4 micrometer, and a value of beam current selected from 25 to 250 na, an electron beam darkening sensitivity in the linear portion of the sensitivity curve, of at least 2.454 unit of optical density value in the spectral range of 365 nm to 630 nm per electron dosage unit of milli coulomb/cm^2, said HEBS-glass having a base glass composition consisting essentially on the mole % oxide basis 11.4 to 17.5% of one or more alkali metal oxide, 2.4 to 10.2% of photosensitivity inhibitors and RS suppressing agents with at least 2.4% being TiO_2; 1.1 to 2.4% $A1_2O_3$; 0 to 4.6% B_2O_3; 3.7 to 13.2% ZnO; 0.5 to 6% Cl; and 58.2 to 78.8% SiO_2.

28. A component having a three dimensional microstructure selected from the group consisting of electrical connections between two metallic layers separated by tapered structures of thick polyimide, bifocal intraocular lenses, widely asymmetric DOE, random phase plate DOEs, miniature compact disc heads, antireflective surface, complex imaging optics, grating couples, polarization-sensitive beam splitters, spectral

filters, wavelength division multiplexers, micro optical elements for head-up and helmet mounted display, micro optical elements for focal plane optical concentration and optical efficiency enhancement, micro optical elements for color separation, beam shaping, and for miniature optical scanners, microlens arrays, diffraction gratings, diffractive lenses, laser diode array collimators and correctors, micro optical elements for aberration correction, hybrid optics, microprism arrays, micromirror arrays, random phase plates and Bragg gratings, two dimensional fanout gratings, optical interconnects, signal switches, fiber pig tailing, DOEs for coupling laser light into a fiber, micro-electro-mechanical sensors and actuators, micro valves, inertial micro sensors, micro machined RF switches, GPS component miniaturization devices, laser scanners, optical shutters, dynamic micro mirrors, optical choppers and optical switches; the component comprising a substrate having a three dimensional microstructure produced by exposing a substrate through a developed analog photoresist with a three dimensional microstructure with an ion beam in an ion beam etching system to transfer the three dimensional microstructure of the developed analog photoresist on to the surface of the substrate in a single step exposure; the analog photoresist with three dimensional microstructure being the product of the process comprising exposing a photoresist to a gray scale pattern in a gray scale mask using an optical lithography tool and developing the exposed photoresist to form three dimensional microstructures in the photoresist; the gray scale mask comprising a transparent High Energy Beam Sensitive-glass (HEBS-glass) having at least one gray scale zone with a plurality of gray scale levels, each gray scale level having a different optical density, the High Energy Beam Sensitive-glass in bodies of 0.090 inch cross section will exhibit the following properties:

(a) a transmittance of more than 88% at 436 nm; and

(b) upon exposure to an electron beam using an electron beam pattern generator operated with a write scheme having a value of acceleration voltage selected from 20 to 30 kV, an addressing grid size of from 0.1 to 0.4 micrometer, and a value of beam current selected from 25 to 250 na, an electron beam darkening sensitivity in the linear portion of the sensitivity curve, of at least 2.454 unit of optical density value in the spectral range of 365 nm to 630 nm per electron dosage unit of milli coulomb/cm^2; said HEBS-glass having a base glass composition consisting essentially on the mole % oxide basis 11.4 to 17.5% of one or more alkali metal oxide, 2.4 to 10.2% of photosensitivity inhibitors and RS suppressing agents with at least 2.4% being TiO_2; 1.1 to 2.4% $A1_2O_3$; 0 to 4.6% B_2O_3; 3.7 to 13.2% ZnO; 0.5 to 6% Cl; and 58.2 to 78.8% SiO_2.

29. A method of producing a component having a three dimensional microstructure selected from the group consisting of tapered structures for microelectronics, micro optical devices, integrated optical components, micro-electro-mechanical devices, micro-opto-electro-mechanical devices, diffractive optical elements, refractive microlens arrays, diffractive microlens, and micromirror arrays, the method comprising exposing a substrate through a developed analog photoresist with a three dimensional microstructure with an ion beam in an ion beam etching system to transfer the three dimensional microstructure of the developed analog photoresist on to the surface of the substrate in a single step exposure; the analog photoresist with three dimensional microstructure being the product of the process of exposing a photoresist to a gray scale pattern in a gray scale mask using an optical lithography tool and developing the exposed photoresist to form three dimensional microstructures in the

photoresist; the gray scale mask comprising a transparent High Energy Beam Sensitive-glass (HEBS-glass) having at least one gray scale zone with a plurality of gray scale levels, each gray scale level having a different optical density, the High Energy Beam Sensitive-glass in bodies of 0.090 inch cross section will exhibit the following properties:

(a) a transmittance of more than 88% at 436 nm; and

(b) upon exposure to an electron beam using an electron beam pattern generator operated with a write scheme having a value of acceleration voltage selected from 20 to 30 kV, an addressing grid size of from 0.1 to 0.4 micrometer, and a value of beam current selected from 25 to 250 na, an electron beam darkening sensitivity in the linear portion of the sensitivity curve, of at least 2.454 unit of optical density value in the spectral range of 365 nm to 630 nm per electron dosage unit of milli coulomb/cm^2; said HEBS-glass having a base glass composition consisting essentially on the mole % oxide basis 11.4 to 17.5% of one or more alkali metal oxide, 2.4 to 10.2% of photosensitivity inhibitors and RS suppressing agents with at least 2.4% being TiO_2; 1.1 to 2.4% $A1_2O_3$; 0 to 4.6% B_2O_3; 3.7 to 13.2% ZnO; 0.5 to 6% Cl; and 58.2 to 78.8% SiO_2.

30. A method of producing a component having a three dimensional microstructure selected from the group consisting of electrical connections between two metallic layers separated by tapered structures of thick polyimide, bifocal intraocular lenses, widely asymmetric DOE, miniature compact disc heads, antireflective surface, complex imaging optics, grating couples, polarization-sensitive beam splitters, spectral filters, wavelength division multiplexers, micro optical elements for head-up and helmet mounted display, micro optical elements for focal plane optical concentration and optical

efficiency enhancement, micro optical elements for color separations, beam shaping, and for miniature optical scanners, microlens arrays, diffraction gratings, diffractive lenses, laser diode array collimators and correctors, micro optical elements for aberration correction, hybrid optics, microprism arrays, micromirror arrays, random phase plates and Bragg gratings, two dimensional fanout gratings, optical interconnects, signal switches, fiber pig tailing, DOEs for coupling laser light into a fiber, micro-electro-mechanical sensors and actuators, micro valves, inertial micro sensors, micro machined RF switches, GPS component miniaturization devices, laser scanners, optical shutters, dynamic micro mirrors, optical shoppers and optical switches; the microlens, and micromirror arrays, the method comprising exposing a substrate through a developed analog photoresist with a three dimensional microstructure with an ion beam in an ion beam etching system to transfer the three dimensional microstructure of the developed analog photoresist on to the surface of the substrate in a single step exposure; the analog photoresist with three dimensional microstructure being the product of the process of exposing a photoresist to a gray scale pattern in a gray scale mask using an optical lithography tool and developing the exposed photoresist to from three dimensional microstructures in the photoresist; the gray scale mask comprising a transparent High Energy Beam Sensitive-glass (HEBS-glass) having at least one gray scale zone with a plurality of gray scale levels, each gray scale level having a different optical density, the High Energy Beam Sensitive-glass in bodies of 0.090 inch cross section will exhibit the following properties:

(a) a transmittance of more than 88% at 436 nm; and

(b) upon exposure to an electron beam using an electron beam pattern generator operated with a write scheme having a value of acceleration voltage

selected from 20 to 30 kV, an addressing grid size of from 0.1 to 0.4 micrometer, and a value of beam current selected from 25 to 250 na, an electron beam darkening sensitivity in the linear portion of the sensitivity curve, of at least 2.454 unit of optical density value in the spectral range of 365 nm to 630 nm per electron dosage unit of milli coulomb/cm^2; said HEBS-glass having a base glass composition consisting essentially on the mole % oxide basis 11.4 to 17.5% of one or more alkali metal oxide, 2.4 to 10.2% of photosensitivity inhibitors and RS suppressing agents with at least 2.4% being TiO_2; 1.1 to 2.4% $A1_2O_3$; 0 to 4.6% B_2O_3; 3.7 to 13.2% ZnO; 0.5 to 6% Cl; and 58.2 to 78.8% SiO_2.

31. A Laser Direct Write-glass (LDW-glass) which is a High Energy Beam Sensitive-glass (HEBS-glass) having at least a portion uniformly darkened to a uniform optical density, said LDW-glass prior to being darkened with an electron beam is a transparent HEBS-glass which in bodies 0.090 inch cross section will exhibit the following properties:

(a) transmittance of more than 88% at 436 nm; and

(b) upon exposure to an electron beam using an electron beam pattern generator operated with a write scheme having a value of acceleration voltage selected from 20 to 30 kV, an addressing grid size selected from 0.1 to 0.4 micrometer, and a value of beam current selected from 25 to 250 na, an electron beam darkening sensitivity in the linear portion of the sensitivity curve of at least 2.454 unit of optical density value in the spectral range of 365 nm to 630 nm per electron dosage unit of milli coulomb/cm^2, said HEBS-glass having a base glass composition consisting essentially on the mole % oxide basis 11.4 to 17.5% of one or more alkali metal oxide, 2.4 to 10.2%

of photosensitivity inhibitors and RS suppressing agents with at least 2.4% TiO_2; 1.1 to 2.4% $A1_2O_3$; 0 to 4.6% B_2O_3; 3.7 to 13.2% ZnO; 0.5 to 6% Cl; and 58.2 to 78.8% SiO_2.

32. A gray scale mask on a Laser Direct Write glass (LDW-glass) produced by darkening at least a portion of a High Energy Beam Sensitive-glass (HEBS-glass) with an electron beam to form a LDW-glass having a uniformly darkened portion having a uniform optical density, the HEBS-glass in bodies of 0.090 inch cross section exhibiting the following properties:

(a) transmittance of more than 88% at 436 nm; and

(b) upon exposure to an electron beam using an electron beam pattern generator operated with a write scheme having a value of acceleration voltage selected from 20 to 30 kV, an addressing grid size selected from 0.1 to 0.4 micrometer, and a value of beam current selected from 25 to 250 na, an electron beam darkening sensitivity in the linear portion of the sensitivity curve of at least 2.454 unit of optical density value in the spectral range of 365 nm to 630 nm per electron dosage unit of milli coulomb/cm^2, said HEBS-glass having a base glass composition consisting essentially on the mole % oxide basis 11.4 to 17.5% of one or more alkali metal oxide, 2.4 to 10.2% of photosensitivity inhibitors and RS suppressing agents with at least 2.4% TiO_2; 1.1 to 2.4% $A1_2O_3$; 0 to 4.6% B_2O_3; 3.7 to 13.2% ZnO; 0.5 to 6% Cl; and 58.2 to 78.8% SiO_2; and exposing a plurality of areas on the uniformly darkened portion of the LDW-glass with a focused laser beam to form a gray scale zone with a plurality of gray scale levels, the optical density of each gray scale level differing from the optical density of adjacent gray scale levels, and the optical density of the darkest gray scale level not exceeding the optical density of the uniformly darkened portion of the LDW-glass.

33. The gray scale mask according to Claim 32 wherein the gray scale zone has a continuous gray scale comprising a plurality of grade scale levels.

34. A method of making a gray scale mask comprising darkening at least a portion of a High Energy Beam Sensitive-glass (HEBS-glass) with an electron beam to form a Laser Direct Write-glass having uniformly darkened portion having a uniform optical density, the HEBS-glass in bodies of 0.090 inch cross section exhibiting the following properties:

(a) transmittance of more than 88% at 436 nm; and

(b) upon exposure to an electron beam using an electron beam pattern generator operated with a write scheme having a value of acceleration voltage selected from 20 to 30 kV, an addressing grid size selected from 0.1 to 0.4 micrometer, and a value of beam current selected from 25 to 250 na, an electron beam darkening sensitivity in the linear portion of the sensitivity curve of at least 2.454 unit of optical density value in the spectral range of 365 nm to 630 nm per electron dosage unit of milli coulomb/cm^2, said HEBS-glass having a base glass composition consisting essentially on the mole % oxide basis 11.4 to 17.5% of one or more alkali metal oxide, 2.4 to 10.2% of photosensitivity inhibitors and RS suppressing agents with at least 2.4% TiO_2; 1.1 to 2.4% $A1_2O_3$; 0 to 4.6% B_2O_3; 3.7 to 13.2% ZnO; 0.5 to 6% Cl; and 58.2 to 78.8% SiO_2; and exposing a plurality of areas on the uniformly darkened portion of the LDW-glass with a focused laser beam to form a gray scale zone with a plurality of gray scale levels, the optical density of each gray scale level differing from the optical density of adjacent

gray scale levels, and the optical density of the darkest gray scale level not exceeding the optical density of the uniformly darkened portion of the LDW-glass.

35. The method according to Claim 34 wherein the focused laser beam exposure write time for each area exposed is different.

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36. The method according to Claim 34 wherein the focused laser beam intensity for each area exposed is different.

37. The method according to Claim 34 wherein the number of retraces of the focused laser beam writing for each area exposed is different.

38. A method of making a three dimensional microstructure with three dimensional surfaces in a photoresist comprising exposing a photoresist to a gray scale pattern in a gray scale mask on a Laser Direct Write-glass ((LDW-glass) using an optical lithography tool and developing the exposed photoresist to form three dimensional microstructures in the photoresist; A gray scale mask on a Laser Direct Write glass (LDW-glass) produced by darkening at least a portion of a High Energy Beam Sensitive-glass (HEBS-glass) with an electron beam to form a LDW-glass having a uniformly darkened portion having a uniform optical density, the HEBS-glass in bodies of 0.090 inch cross section exhibiting the following properties:

(a) transmittance of more than 88% at 436 nm; and

(b) upon exposure to an electron beam using an electron beam pattern generator operated with a write scheme having a value of acceleration voltage

selected from 20 to 30 kV, an addressing grid size selected from 0.1 to 0.4 micrometer, and a value of beam current selected from 25 to 250 na, an electron beam darkening sensitivity in the linear portion of the sensitivity curve of at least 2.454 unit of optical density value in the spectral range of 365 nm to 630 nm per electron dosage unit of milli coulomb/cm^2, said HEBS-glass having a base glass composition consisting essentially on the mole % oxide basis 11.4 to 17.5% of one or more alkali metal oxide, 2.4 to 10.2% of photosensitivity inhibitors and RS suppressing agents with at least 2.4% TiO_2; 1.1 to 2.4% $A1_2O_3$; 0 to 4.6% B_2O_3; 3.7 to 13.2% ZnO; 0.5 to 6% Cl; and 58.2 to 78.8% SiO_2; and exposing a plurality of areas on the uniformly darkened portion of the LDW-glass with a focused laser beam to form a gray scale zone with a plurality of gray scale levels, the optical density of each gray scale level differing from the optical density of adjacent gray scale levels, and the optical density of the darkest gray scale level not exceeding the optical density of the uniformly darkened portion of the LDW-glass.

39. An analog photoresist with a three dimensional microstructure produced by exposing a photoresist to a gray scale pattern in a gray scale mask on a Laser Direct Write-glass (LDW-glass) using an optical lithography tool and developing the exposed photoresist to form the three dimensional microstructure in the photoresist; the gray scale mask comprising:

A gray scale mask on a Laser Direct Write glass (LDW-glass) produced by darkening at least a portion of a High Energy Beam Sensitive-glass (HEBS-glass) with an electron beam to form a LDW-glass having a uniformly darkened portion having a uniform optical density, the HEBS-glass in bodies of 0.090 inch cross section exhibiting the following properties:

(a) transmittance of more than 88% at 436 nm; and

(b) upon exposure to an electron beam using an electron beam pattern generator operated with a write scheme having a value of acceleration voltage selected from 20 to 30 kV, an addressing grid size selected from 0.1 to 0.4 micrometer, and a value of beam current selected from 25 to 250 na, an electron beam darkening sensitivity in the linear portion of the sensitivity curve of at least 2.454 unit of optical density value in the spectral range of 365 nm to 630 nm per electron dosage unit of milli coulomb/cm^2, said HEBS-glass having a base glass composition consisting essentially on the mole % oxide basis 11.4 to 17.5% of one or more alkali metal oxide, 2.4 to 10.2% of photosensitivity inhibitors and RS suppressing agents with at least 2.4% TiO_2; 1.1 to 2.4% $A1_2O_3$; 0 to 4.6% B_2O_3; 3.7 to 13.2% ZnO; 0.5 to 6% Cl; and 58.2 to 78.8% SiO_2; and exposing a plurality of areas on the uniformly darkened portion of the LDW-glass with a focused laser beam to form a gray scale zone with a plurality of gray scale levels, the optical density of each gray scale level differing from the optical density of adjacent gray scale levels, and the optical density of the darkest gray scale level not exceeding the optical density of the uniformly darkened portion of the LDW-glass.

40. A method of producing three dimensional microstructures in substrate material comprising exposing a substrate through a developed analog photoresist with a three dimensional microstructure with an ion beam in an ion beam etching system to transfer the three dimensional microstructure of the developed analog photoresist on to the surface of the substrate in a single step exposure; the analog photoresist with three dimensional microstructure being the product of the process comprising exposing a photoresist to a gray scale pattern in a gray scale mask on a Laser Direct Write-glass

(LDW-glass) using an optical lithography tool and developing the exposed photoresist to form three dimensional microstructures in the photoresist; the gray scale mask comprising a LDW-glass having at least one gray scale zone with a plurality of gray scale levels, each gray scale level having a different optical density, the gray scale mask produced by darkening at least a portion of a High Energy Beam Sensitive-glass (HEBS-glass) with an electron beam to form a LDW-glass having a uniformly darkened portion having a uniform optical density, the HEBS-glass in bodies of 0.090 inch cross section exhibiting the following properties:

(a) transmittance of more than 88% at 436 nm; and

(b) upon exposure to an electron beam using an electron beam pattern generator operated with a write scheme having a value of acceleration voltage selected from 20 to 30 kV, an addressing grid size selected from 0.1 to 0.4 micrometer, and a value of beam current selected from 25 to 250 na, an electron beam darkening sensitivity in the linear portion of the sensitivity curve of at least 2.454 unit of optical density value in the spectral range of 365 nm to 630 nm per electron dosage unit of milli coulomb/cm^2, said HEBS-glass having a base glass composition consisting essentially on the mole % oxide basis 11.4 to 17.5% of one or more alkali metal oxide, 2.4 to 10.2% of photosensitivity inhibitors and RS suppressing agents with at least 2.4% TiO_2; 1.1 to 2.4% $A1_2O_3$; 0 to 4.6% B_2O_3; 3.7 to 13.2% ZnO; 0.5 to 6% Cl; and 58.2 to 78.8% SiO_2; and exposing a plurality of areas on the uniformly darkened portion of the LDW-glass with a focused laser beam to form a gray scale zone with a plurality of gray scale levels, the optical density of each gray scale level differing from the optical density of adjacent gray scale levels, and the optical density of the darkest gray scale level not exceeding the optical density of the uniformly darkened portion of the LDW-glass.

41. A component having a three dimensional microstructure selected from the group consisting of tapered structures for microelectronics, micro-optical devices, integrated optical components, micro-electro-mechanical devices, micro-opto-electro-mechanical devices, microelectrical devices, diffractive optical elements (DOE), refractive microlens arrays, micromirror arrays, and diffractive microlens arrays; the component comprising a substrate having a three dimensional microstructure produced by exposing a substrate through a developed analog photoresist with a three dimensional microstructure with an ion beam in an ion beam etching system to transfer the three dimensional microstructure of the developed analog photoresist on to the surface of the substrate in a single step exposure; the analog photoresist with three dimensional microstructure being the product of the process comprising exposing a photoresist to a gray scale pattern in a gray scale mask on a Laser Direct Write-glass (LDW-glass) using an optical lithography tool and developing the exposed photoresist to form three dimensional microstructures in the photoresist; the gray scale mask comprising a LDW-glass having at least one gray scale zone with a plurality of gray scale levels, each gray scale level having a different optical density, the gray scale mask produced by darkening at least a portion of a High Energy Beam Sensitive-glass (HEBS-glass) with an electron beam to form a LDW-glass having a uniformly darkened portion having a uniform optical density, the HEBS-glass in bodies of 0.090 inch cross section exhibiting the following properties:

(a) transmittance of more than 88% at 436 nm; and

(b) upon exposure to an electron beam using an electron beam pattern generator operated with a write scheme having a value of acceleration voltage

selected from 20 to 30 kV, an addressing grid size selected from 0.1 to 0.4 micrometer, and a value of beam current selected from 25 to 250 na, an electron beam darkening sensitivity in the linear portion of the sensitivity curve of at least 2.454 unit of optical density value in the spectral range of 365 nm to 630 nm per electron dosage unit of milli coulomb/cm^2, said HEBS-glass having a base glass composition consisting essentially on the mole % oxide basis 11.4 to 17.5% of one or more alkali metal oxide, 2.4 to 10.2% of photosensitivity inhibitors and RS suppressing agents with at least 2.4% TiO_2; 1.1 to 2.4% $A1_2O_3$; 0 to 4.6% B_2O_3; 3.7 to 13.2% ZnO; 0.5 to 6% Cl; and 58.2 to 78.8% SiO_2; and exposing a plurality of areas on the uniformly darkened portion of the LDW-glass with a focused laser beam to form a gray scale zone with a plurality of gray scale levels, the optical density of each gray scale level differing from the optical density of adjacent gray scale levels, and the optical density of the darkest gray scale level not exceeding the optical density of the uniformly darkened portion of the LDW-glass.

42. A component having a three dimensional microstructure selected from the group consisting of electrical connections between two metallic layers separated by tapered structures of thick polyimide, bifocal intraocular lenses, widely asymmetric DOE, miniature compact disc heads, antireflective surface, complex imaging optics, grating couples, polarization-sensitive beam splitters, spectral filters, wavelength division multiplexers, micro optical elements for head-up and helmet mounted display, micro optical elements for focal plane optical concentration and optical efficiency enhancement, micro optical elements for color separation, beam shaping, and for miniature optical scanners, microlens arrays, diffraction gratings, diffractive lenses, laser diode array collimators and correctors, micro optical elements for aberration correction,

hybrid optics, microprism arrays, micromirror arrays, random phase plates and Bragg gratings, two dimensional fanout gratings, optical interconnects, signal switches, fiber pig tailing, DOEs for coupling laser light into a fiber, micro-electro-mechanical sensors and actuators, micro valves, inertial micro sensors, micro machined RF switches, GPS component miniaturization devices, laser scanners, optical shutters, dynamic micro mirrors, optical choppers and optical switches; the component comprising a substrate having a three dimensional microstructure produced by exposing a substrate through a developed analog photoresist with a three dimensional microstructure with an ion beam in an ion beam etching system to transfer the three dimensional microstructure of the developed analog photoresist on to the surface of the substrate in a single step exposure; the analog photoresist with three dimensional microstructure being the product of the process comprising exposing a photoresist to a gray scale pattern in a gray scale mask on a Laser Direct Write-glass (LDW-glass) using an optical lithography tool and developing the exposed photoresist to form three dimensional microstructures in the photoresist; the gray scale mask comprising a transparent High Energy Beam Sensitive-glass having at least one gray scale zone with a plurality of gray scale levels, each gray scale level having a different optical density, the gray scale produced by darkening at least a portion of a High Energy Beam Sensitive-glass (HEBS-glass) with an electron beam to form a LDW-glass having a uniformly darkened portion having a uniform optical density, the HEBS-glass in bodies of 0.090 inch cross section exhibiting the following properties:

(a) transmittance of more than 88% at 436 nm; and

(b) upon exposure to an electron beam using an electron beam pattern generator operated with a write scheme having a value of acceleration voltage

selected from 20 to 30 kV, an addressing grid size selected from 0.1 to 0.4 micrometer, and a value of beam current selected from 25 to 250 na, an electron beam darkening sensitivity in the linear portion of the sensitivity curve of at least 2.454 unit of optical density value in the spectral range of 365 nm to 630 nm per electron dosage unit of milli coulomb/cm^2, said HEBS-glass having a base glass composition consisting essentially on the mole % oxide basis 11.4 to 17.5% of one or more alkali metal oxide, 2.4 to 10.2% of photosensitivity inhibitors and RS suppressing agents with at least 2.4% TiO_2; 1.1 to 2.4% $A1_2O_3$; 0 to 4.6% B_2O_3; 3.7 to 13.2% ZnO; 0.5 to 6% Cl; and 58.2 to 78.8% SiO_2; and exposing a plurality of areas on the uniformly darkened portion of the LDW-glass with a focused laser beam to form a gray scale zone with a plurality of gray scale levels, the optical density of each gray scale level differing from the optical density of adjacent gray scale levels, and the optical density of the darkest gray scale level not exceeding the optical density of the uniformly darkened portion of the LDW-glass.

43. A method of producing a component having a three dimensional microstructure selected from the group consisting of tapered structures for microelectronics, micro optical devices, integrated optical components, micro-electro-mechanical devices, micro-opto-electro-mechanical devices, diffractive optical elements, refractive microlens arrays, diffractive microlens, and micromirror arrays, the method comprising exposing a substrate through a developed analog photoresist with a three dimensional microstructure with an ion beam in an ion beam etching system to transfer the three dimensional microstructure of the developed analog photoresist on to the surface of the substrate in a single step exposure; the analog photoresist with three dimensional microstructure being the product of the process of exposing a photoresist to

a gray scale pattern in a gray scale mask on a Laser Direct Write-glass (LDW-glass) using an optical lithography tool and developing the exposed photoresist to form three dimensional microstructures in the photoresist; the gray scale mask comprising a transparent High Energy Beam Sensitive-glass having at least one gray scale zone with a plurality of gray scale levels, each gray scale level having a different optical density, the gray scale mask produced by darkening at least a portion of a High Energy Beam Sensitive-glass (HEBS-glass) with an electron beam to form a LDW-glass having a uniformly darkened portion having a uniform optical density, the HEBS-glass in bodies of 0.090 inch cross section exhibiting the following properties:

(a) transmittance of more than 88% at 436 nm; and

(b) upon exposure to an electron beam using an electron beam pattern generator operated with a write scheme having a value of acceleration voltage selected from 20 to 30 kV, an addressing grid size selected from 0.1 to 0.4 micrometer, and a value of beam current selected from 25 to 250 na, an electron beam darkening sensitivity in the linear portion of the sensitivity curve of at least 2.454 unit of optical density value in the spectral range of 365 nm to 630 nm per electron dosage unit of milli coulomb/cm^2, said HEBS-glass having a base glass composition consisting essentially on the mole % oxide basis 11.4 to 17.5% of one or more alkali metal oxide, 2.4 to 10.2% of photosensitivity inhibitors and RS suppressing agents with at least 2.4% TiO_2; 1.1 to 2.4% $A1_2O_3$; 0 to 4.6% B_2O_3; 3.7 to 13.2% ZnO; 0.5 to 6% Cl; and 58.2 to 78.8% SiO_2; and exposing a plurality of areas on the uniformly darkened portion of the LDW-glass with a focused laser beam to form a gray scale zone with a plurality of gray scale levels, the optical density of each gray scale level differing from the optical density of adjacent

gray scale levels, and the optical density of the darkest gray scale level not exceeding the optical density of the uniformly darkened portion of the LDW-glass.

44. A method of producing a component having a three dimensional microstructure selected from the group consisting of electrical connections between two metallic layers separated by tapered structures of thick polyimide, bifocal intraocular lenses, widely asymmetric DOE, miniature compact disc heads, antireflective surface, complex imaging optics, grating couples, polarization-sensitive beam splitters, spectral filters, wavelength division multiplexers, micro optical elements for head-up and helmet mounted display, micro optical elements for focal plane optical concentration and optical efficiency enhancement, micro optical elements for color separations, beam shaping, and for miniature optical scanners, microlens arrays, diffraction gratings, diffractive lenses, laser diode array collimators and correctors, micro optical elements for aberration correction, hybrid optics, microprism arrays, micromirror arrays, random phase plates and Bragg gratings, two dimensional fanout gratings, optical interconnects, signal switches, fiber pig tailing, DOEs for coupling laser light into a fiber, micro-electro-mechanical sensors and actuators, micro valves, inertial micro sensors, micro machined RF switches, GPS component miniaturization devices, laser scanners, optical shutters, dynamic micro mirrors, optical shoppers and optical switches; the microlens, and micromirror arrays, the method comprising exposing a substrate through a developed analog photoresist with a three dimensional microstructure with an ion beam in an ion beam etching system to transfer the three dimensional microstructure of the developed analog photoresist on to the surface of the substrate in a single step exposure; the analog photoresist with three dimensional microstructure being the product of the

process of exposing a photoresist to a gray scale pattern in a gray scale mask on a Laser Direct Write-glass (LDW-glass) using an optical lithography tool and developing the exposed photoresist to from three dimensional microstructures in the photoresist; the gray scale mask comprising a transparent High Energy Beam Sensitive-glass having at least one gray scale zone with a plurality of gray scale levels, each gray scale level having a different optical density, the gray scale mask produced by darkening at least a portion of a High Energy Beam Sensitive-glass (HEBS-glass) with an electron beam to form a LDW-glass having a uniformly darkened portion having a uniform optical density, the HEBS-glass in bodies of 0.090 inch cross section will exhibit the following properties:

(a) transmittance of more than 88% at 436 nm; and

(b) upon exposure to an electron beam using an electron beam pattern generator operated with a write scheme having a value of acceleration voltage selected from 20 to 30 kV, an addressing grid size selected from 0.1 to 0.4 micrometer, and a value of beam current selected from 25 to 250 na, an electron beam darkening sensitivity in the linear portion of the sensitivity curve of at least 2.454 unit of optical density value in the spectral range of 365 nm to 630 nm per electron dosage unit of milli coulomb/cm^2, said HEBS-glass having a base glass composition consisting essentially on the mole % oxide basis 11.4 to 17.5% of one or more alkali metal oxide, 2.4 to 10.2% of photosensitivity inhibitors and RS suppressing agents with at least 2.4% TiO_2; 1.1 to 2.4% $A1_2O_3$; 0 to 4.6% B_2O_3; 3.7 to 13.2% ZnO; 0.5 to 6% Cl; and 58.2 to 78.8% SiO_2; and exposing a plurality of areas on the uniformly darkened portion of the LDW-glass with a focused laser beam to form a gray scale zone with a plurality of gray scale levels, the optical density of each gray scale level differing from the optical density of adjacent